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INFORMATION DISPLAY DEVICE

FIELD OF THE INVENTION

The present invention pertains to an information display device, and more particularly, to an information display device equipped with a display having a memory capability.

BACKGROUND OF THE INVENTION

The conventional art has focused on the use of chiral nematic liquid crystal that exhibits a cholesteric phase as a display medium. Because this type of liquid crystal has a memory capability, power is needed only when image is drawn, and the supply of power may be terminated when the display of an image is being maintained, making it ideal for low energy consumption. It is also capable of color and large-screen display.

Therefore, it may be widely used in small to large items, i.e., from portable terminal devices such as electronic books to indoor or outdoor billboards or bulletin boards.

However, because this type of liquid crystal has a memory capability, where it is equipped with a power supply unit that entails an unstable supply of power, such as a dry battery, a battery or a solar battery, if the power supply runs out while an image is being redrawn, or if the supply of power is terminated due to insufficient charging, the image becomes stored in the memory in an incomplete or distorted fashion. While this might not be a significant problem where the user is an individual, it would appear very unsightly on a display used in a public location.

Moreover, where the screen can be reset to a prescribed display condition or a different display can be made to appear once the reset operation is performed, the following problems may occur: the screen present when the reset operation was performed may remain on the screen without display information, or some of the previous display may remain on the supposedly reset screen.

BRIEF SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide an information display device in which the problem of incomplete screen display due to a failure of the power supply is prevented from occurring.

In order to achieve the object described above, the information display device pertaining to the present invention is equipped with a display that requires power when performing image draw and stores the drawn image in memory after the supply of power terminates, a power supply that supplies power for the driving of the display, a detecting means to detect the level of voltage supplied by the power supply, and a control means that prevents the image redraw operation from being performed as to at least a part of the display based on the level of voltage detected by the detecting means.

In the invention having the construction described above, the level of voltage being supplied from the power supply is detected in order to determine whether or not sufficient power remains in the power supply to redraw the image on the display, and if redraw using the remaining power is not possible, image redraw is prohibited. Therefore, the problems of (i) termination of power during image redraw leading to an incomplete or distorted image remaining on the display, or (ii) an old image remaining after reset, may be prevented.

In the present invention, where the detected voltage level is less than a reference level, for example, the image redraw operation for the entire screen is prohibited. Alternatively, if the display is divided into multiple divisions and is able to display independent images, even though total screen redraw is prohibited, redraw is permitted for at least some divisions of the screen as to which redraw is possible.

It is also acceptable if a display unit that uses a very small amount of power in displaying a message that redraw is forbidden, such as an LED or a small liquid crystal device, is located in a corner of the screen, such that a message that redraw is forbidden is displayed on this unit when the image redraw operation is prohibited. This display also indicates that the power supply has been exhausted. It is also acceptable if the message indicating that screen redraw is forbidden is displayed in a part of the display screen. If only a very small part of the screen is used, this message may be displayed with only the minute amount of remaining power.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing the basic construction of an information display device of a first embodiment of the present invention;

Fig. 2 is a graph showing a voltage fluctuation characteristic of a power supply of the present invention;

Fig. 3 is a flow chart showing a control sequence for the first embodiment of the present invention;

Fig. 4 is a block diagram showing the basic construction of an information display device of a second embodiment of the present invention;

Fig. 5 is a front elevation of a liquid crystal display of the second embodiment of the present invention;

Fig. 6 is a flow chart showing a control sequence for the second embodiment of the present invention;

Fig. 7 is a block diagram showing the basic construction of an information display device of a third embodiment of the present invention;

Fig. 8 is a front elevation of a liquid crystal display of the third embodiment of the present invention;

Fig. 9 is a flow chart showing a control sequence for the third embodiment of the present invention;

Fig. 10 is a block diagram showing the basic construction of an information display device of a fourth embodiment of the present invention;

Fig. 11 is a front elevation of a liquid crystal display of the fourth embodiment of the present invention; and

Fig. 12 is a flow chart showing a control sequence for the fourth embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Embodiments of the information display device pertaining to the present invention will now be explained with reference to the accompanying drawings.

As shown in the block diagram of Fig. 1, the information display device of a first embodiment of the present invention comprises a liquid crystal display 10, a power supply 15 to drive the liquid crystal display 10, a detection circuit 20 to detect the level of voltage supplied from the power supply 15, a CPU 25 that performs overall control, and a memory 30 that stores image data to be displayed.

The screen of the liquid crystal display 10 comprises a liquid crystal material that requires electric power when image draw is performed, and that saves the written image in memory when the supply of power is stopped, i.e., may maintain the display after the power supply terminates. Types of liquid crystal material having this characteristic include cholesteric liquid crystal and chiral nematic liquid crystal. Cholesteric liquid crystal and chiral nematic liquid crystal have the following advantages: display using selective reflection based on the cholesteric phase of the liquid crystal is possible, it is simple to achieve a construction that does not require back lighting, and a color display is easily attained. Therefore, they are particularly suited for a display device in which the screen is redrawn relatively infrequently and the same display must remain on the screen for a long time, such as a sign, billboard, bulletin board, traffic sign or

other display device that displays information to the general public, or for a reading device such as an electronic book or electronic newspaper.

As the liquid crystal-based screen construction and display driving method are already known, their explanation will be omitted here. Where a liquid crystal display is used, the display device may be made thin and lightweight.

Any item of image data stored in the memory 30 is sent to the liquid crystal display 10 together with a control signal based on the instruction from the CPU 25, and is displayed on the screen. The necessary power is supplied by the power supply 15. The power supply 15 comprises a battery, for example, a dry battery or a solar battery, and the level of voltage supplied is detected by the detection circuit 20.

The voltage supplied by the power supply 15 and the decline in the voltage supplied by the power supply 15 will now be explained with reference to Fig. 2. If it is a new power supply, or if it has recently been recharged and has a large amount of charge remaining, sufficient voltage V_{E1} may be supplied, as indicated by line (A). Here, when the display 10 begins to be driven (i.e., the power supply is turned ON), after the initial decline, there is no further decline, and after the driving is stopped (i.e., the power supply is turned OFF), the voltage level immediately recovers to V_{E1}.

On the other hand, if the power supply has been used to some extent, and there is little charge remaining,

only the low level of voltage V_{E2} can be supplied, as shown by line (B), and when the display 10 is driven, after the initial decline, the voltage continues to fall gradually, such that even if the driving is stopped, the voltage level does not recover to V_{E2}.

The voltage level V_{MIN} in Fig. 2 is the minimum level of voltage necessary to redraw the image on the liquid crystal display 10. If the voltage falls below this level, either the driving of the liquid crystal display 10 itself or the operation of the CPU 25 stops, and as a result, the redrawing of the image on the screen is stopped partway through.

The voltage level V_{E2} can be anticipated beforehand for each system, and if the supplied voltage monitored by the detection circuit 20 equals or exceeds the level V_{E2}, the CPU 25 permits image redraw to be performed, while if the supplied voltage is not maintained at V_{E2}, image redraw is prohibited. In this description, the reference voltage refers to this voltage level V_{E2}. However, the level at which the reference voltage should be set depends on the type of power supply 15.

For example, where the power supply 15 is an accumulating power supply such as a dry battery or a rechargeable battery, when a system operation such as image redraw is performed, the amount of power remaining declines in direct relation to the amount of power consumed, and consequently, the level of voltage provided by the power supply further declines after the system operation is performed. As a result, in this case, the reference voltage must be set taking into consideration

the degree of decline in the amount of power remaining. On the other hand, where the power supply 15 is of a type that can generate electricity, such as a solar battery, so long as the amount of light does not decline, there is basically no decline in the power level even after the system operation is performed. Therefore, only the decline in voltage due to a change in the amount of light striking the solar battery and the decline in voltage due to the driving of the liquid crystal display 10 need be taken into account when setting the reference voltage level.

Next, the control sequence for the image redraw operation in the first embodiment will be explained in summary fashion with reference to Fig. 3.

When the image redraw operation is performed, first, the power supply voltage is detected in step S1, and it is determined in step S2 whether or not the detected voltage level equals or exceeds the reference voltage set beforehand. If the detected voltage level equals or exceeds the reference voltage, the liquid crystal display 10 is driven in step S3 and image redraw is performed. If the detected voltage level is less than the reference voltage, this subroutine comes to an end. In other words, image redraw is prohibited and is not performed.

The information display device of a second embodiment of the present invention is as shown in Figs. 4 and 5. Its construction is essentially identical to that of the first embodiment shown in Fig. 1. It differs in that a small display 12 is located next to the corner of the screen 11 of the liquid crystal display 10.

This small display 12 is a liquid crystal display element that can be driven on a very small amount of power, and where the power supply voltage is less than the reference voltage, it indicates that image redraw is forbidden. The indication that image redraw is forbidden can be carried out in a number of ways. One suitable display is indicated by the enlarged drawing shown at the right side of Fig. 5. A warning provided in a single color may be used as well.

When the image redraw operation in the second embodiment is performed, as shown in Fig. 6, if it is determined in step S2 that the power supply voltage is less than the reference voltage, the small display 12 is driven in step S4 to indicate that image redraw is forbidden. The other steps in the control sequence shown in Fig. 6 are the same as those shown in Fig. 3.

In the second embodiment, various types of display elements may be used for the small display 12, including not only a liquid crystal display element (in this case, an element having a memory capability is preferred) but also a photoemitter element such as an LED element, which may be used as a warning lamp.

The information display device of a third embodiment of the present invention is as shown in Figs. 7 and 8. Its construction is essentially identical to that of the first embodiment shown in Fig. 1. It differs in that (i) it has a screen section 11c to indicate that image redraw is forbidden which is located at the lower right corner of the screen 11 of the liquid crystal display 10,

and (ii) the memory 30 comprises a total screen memory 31 and a screen section memory 32.

Because this screen section 11c has a very small area, it may be driven by an extremely small amount of power. If the power supply voltage is less than the reference voltage, it indicates that image redraw is forbidden. This indication may be carried out using various methods, such as the method shown in Fig. 5 incorporating characters and a drawing.

When the image redraw operation in the third embodiment is performed, as shown in Fig. 9, the power supply voltage is detected in step S11, and it is determined in step S12 whether or not the detected voltage level equals or exceeds the pre-set reference voltage comprising the minimum voltage necessary to redraw the entire screen 11. If the power supply voltage equals or exceeds the reference voltage, the entire screen 11 is driven and the image is redrawn in step S13.

On the other hand, if the reference voltage for the redraw of the entire screen is not met, it is then determined in step S14 whether or not the detected voltage level equals or exceeds the pre-set reference voltage comprising the minimum voltage necessary to redraw the screen section 11c. If this reference voltage is met, the screen section 11c is driven in step S15 to indicate that image redraw is forbidden. If the detected voltage level is less than the reference voltage necessary to redraw the screen section 11c, this subroutine comes to an end.

In this way, if the detected voltage level does not equal or exceed the reference voltage, the image redraw operation for the entire screen 11 of the liquid crystal display is prohibited, and if the detected voltage level is less than the reference voltage necessary to redraw the screen section 11c, the image redraw operation for the screen section 11c is also prohibited.

In the third embodiment, where the liquid crystal display 10 comprises three stacked layers of liquid crystal cells that selectively reflect the primary colors of R, G and B, respectively, the screen section 11c that indicates that image redraw is forbidden may comprise any one of those layers.

The information display device of a fourth embodiment of the present invention is as shown in Figs. 10 and 11. Its construction is essentially identical to that of the third embodiment shown in Figs. 7 and 8. It differs in that the screen 11 of the liquid crystal display 10 is divided into two half-size screens 11a and 11b, each of which can independently display a different image. The screen section 11c that indicates that image redraw is forbidden is located at the lower right corner of the half-size screen 11b. The memory 30 has, in addition to the entire screen memory 31 and the screen section memory 32, a half-size screen memory 33. The CPU 25 issues instructions regarding which of the half-size screens 11a and 11b will be used to display the half-size images.

When the image redraw operation in the fourth embodiment is performed, as shown in Fig. 12, first, the

power supply voltage is detected in step S21, and it is determined in step S22 whether or not the detected voltage level equals or exceeds the pre-set reference voltage comprising the minimum voltage necessary to redraw the entire screen 11. If the power supply voltage equals or exceeds the reference voltage, the entire screen 11 or the two half-size screens 11a and 11b are driven and the image is redrawn in step S23.

On the other hand, if the reference voltage for the entire screen is not met, it is then determined in step S24 whether or not redraw of either of the half-size screens 11a and 11b is instructed. If redraw of one of the half-size screens is instructed, it is determined in step S25 whether or not the detected voltage level equals or exceeds the pre-set reference voltage comprising the minimum voltage necessary to redraw a half-size screen. If the detected voltage level equals or exceeds this reference voltage, either the half-size screen 11a or the half-size screen 11b is driven and its image is redrawn in step S26.

If the detected voltage level fails to reach the reference voltage for a half-size screen, it is determined in step S27 whether or not the detected voltage level equals or exceeds the pre-set reference voltage comprising the minimum voltage necessary to redraw the screen section 11c. If this reference voltage is met, the screen section 11c is driven in step S28 to indicate that image redraw is forbidden. If the detected voltage level is less than the reference voltage necessary to redraw the screen section 11c, this subroutine comes to an end.

In this way, if the detected voltage level does not equal or exceed the reference voltage for the redraw of the entire screen, the image redraw operation for the entire screen 11 of the liquid crystal display 10 is prohibited. If the detected voltage level is less than the reference voltage necessary for the redraw of a half-size screen, the image redraw operation for the half-size screens 11a or 11b is prohibited. If the detected voltage level is less than the reference voltage necessary to redraw the screen section 11c, the image redraw operation for the screen section 11c is prohibited.

Incidentally, where this information display device is used as a bulletin board or billboard, the intended viewers of the liquid crystal display 10 are ordinary persons, not the operators of the system, so the "redraw forbidden" indication that is given in accordance with the state of the power supply is not necessary, and would rather tend to be an unattractive eyesore. For this reason, the construction of the first embodiment in which the "redraw forbidden" indication is not given and the previous image is left on the display is the simplest construction.

If the liquid crystal display 10 is located at a distance from a host device, where it is determined that image redraw is forbidden, that fact may be communicated to the host device by means of a telephone line or other means of communication. Alternatively, it is acceptable if that fact is stored in the CPU 25 and made accessible to the operator.

Although the present invention has been described with reference to a presently preferred embodiment, it will be appreciated by those skilled in the art that various modifications, alternatives, variations, etc. may be made without departing from the spirit and scope of the invention as defined in the appended claims. In particular, the construction of the liquid crystal display and of the overall display system may be freely determined. Further, the entire disclosure of Japanese Patent Application No. 11-244548, filed on August 31, 1999, including the specification, claims, drawings, and abstract, are hereby incorporated by reference in its entirety.